

Claims

1. A method of manufacturing a glass tube, wherein stress exerted on an inner or outer circumferential side of said glass tube is controlled when a columnar or cylindrical glass material is heated and softened by a heating element disposed around said glass material and a piercing plug is relatively pressed into a softened region of said glass material to thereby form said glass material into said glass tube gradually.

2. The method of manufacturing a glass tube according to Claim 1, wherein said stress is controlled by controlling an internal or external pressure of said glass tube.

3. The method of manufacturing a glass tube according to Claim 2, wherein said stress is controlled so that a pressure deviation between the internal pressure and the external pressure of said glass tube is kept substantially constant.

4. The method of manufacturing a glass tube according to Claim 1, wherein said stress is controlled by heating said piercing plug to a temperature of not lower than a softening point of said glass material.

5. The method of manufacturing a glass tube according to Claim 1, wherein said piercing plug is surface-coated so that at least one part of said piercing plug being contact with said glass material contains any one of silicon carbide, pyrolytic carbon and metal carbide.

6. The method of manufacturing a glass tube according to Claim 1, wherein a supporting pipe is welded to at least one end of said columnar or cylindrical glass material so that said glass material is formed into said glass tube gradually while supported by said supporting pipe.

7. The method of manufacturing a glass tube according to Claim 1, wherein said piercing plug has a tapered end, and a cylindrical or columnar portion with a constant outer diameter starting from the middle of said piercing plug, and said glass material is cooled to a temperature at which a sectional shape of said glass material is self-sustained while the softened glass material comes into contact with said columnar or cylindrical portion of said piercing plug inserted into said glass material.

8. The method of manufacturing a glass tube according

to Claim 1, wherein said glass material is formed into said glass tube gradually by said piercing plug which is supported by a support jig having a gradient diameter portion whose outer diameter gradually decreases as a distance from said piercing plug increases.

9. The method of manufacturing a glass tube according to Claim 1, wherein a positioning dent configured so that it can guide said piercing plug to a predetermined position is provided in an end surface of said columnar or cylindrical glass material, and said glass material begins to be formed into said glass tube gradually in the condition that said piercing plug is made to abut on said positioning dent.

10. A method of manufacturing a glass tube, wherein, when a columnar or cylindrical glass material is heated and softened by a heating element disposed around said glass material and a piercing plug is relatively pressed into a softened region of said glass material to thereby form said glass material into said glass tube gradually, a pressure at which said piercing plug is relatively pressed into the softened region of said glass material is detected and a detection signal is fed back for adjusting a quantity of heat generated by said heating element to

keep said pressure constant.

11. The method of manufacturing a glass tube according to Claim 10, wherein a supporting pipe is welded to at least one end of said columnar or cylindrical glass material so that said glass material is formed into said glass tube gradually while supported by said supporting pipe.

12. The method of manufacturing a glass tube according to Claim 10, wherein said piercing plug has a tapered end, and a cylindrical or columnar portion with a constant outer diameter starting from the middle of said piercing plug, and said glass material is cooled to a temperature at which a sectional shape of said glass material is self-sustained while the softened glass material comes into contact with said columnar or cylindrical portion of said piercing plug inserted into said glass material.

13. The method of manufacturing a glass tube according to Claim 10, wherein said glass material is formed into said glass tube gradually by said piercing plug which is supported by a support jig having a gradient diameter portion whose outer diameter gradually decreases as a distance from said piercing plug increases.

14. The method of manufacturing a glass tube according to Claim 10, wherein a positioning dent configured so that it can guide said piercing plug to a predetermined position is provided in an end surface of said columnar or cylindrical glass material, and said glass material begins to be formed into said glass tube gradually in the condition that said piercing plug is made to abut on said positioning dent.

15. An apparatus for manufacturing a glass tube, comprising:

a heating element disposed to surround said glass material;

a piercing plug operable to be pressed into a softened region of said glass material to affect formation of said glass material into said glass tube;

a pressure detecting unit operable to detect a pressure at which said piercing plug is pressed into said glass material; and

a controller operable to control a quantity of heat generated by said heating element on the basis of a detection signal fed back from said pressure detecting unit to keep said pressure constant.

16. An apparatus for manufacturing a glass tube, comprising:

a heating element disposed to surround a glass material;

a piercing plug operable to be pressed into a softened region of said glass material to affect formation of said glass material into said glass tube; and

a gas supply and discharge portion for supplying and discharging a gas, wherein said gas supply and discharge portion is operable to control flow rate of said gas so that an internal or external pressure of said glass tube is controlled.

17. The apparatus for manufacturing a glass tube according to Claim 16, wherein said gas supply portion supplies a gas to an inner or outer circumferential side of said glass material.

18. An apparatus for manufacturing a glass tube, comprising:

a heating element disposed to surround a glass material;

a piercing plug operable to be pressed into a softened region of said glass material to affect formation of said glass material into said glass tube; and

an inductive heater operable to heat said piercing plug to a temperature equal to or higher than a softening point of said glass material,

wherein said heating element is divided into two or more parts in the piercing direction of said glass material.

19. An apparatus for manufacturing a glass tube, comprising:

a heating element disposed to surround a glass material;

a piercing plug operable to be pressed into a softened region of said glass material to affect formation of said glass material into said glass tube;

a feed table operable to be self-propelled by a motor at a desired speed and having a chuck for grasping a piercing-terminating end side of said glass material; and

a controller operable to increase and decrease temperature of said heating element on the basis of a current or a voltage of said motor.

20. An apparatus of manufacturing a glass tube, comprising:

a heating element including a muffle tube and

disposed to surround a glass material;

a piercing plug operable to be pressed into a softened region of said glass material to affect formation of said glass material into said glass tube;

a pressure detecting unit operable to detect a pressure at which said piercing plug is pressed into said glass material; and

a controller operable to control flow rate of a gas which is introduced into said muffle tube through a mass flow controller, on the basis of a detection signal fed back from said pressure detecting unit.

21. An apparatus for manufacturing a glass tube, comprising:

a heating element including a muffle tube and disposed to surround a glass material;

a piercing plug operable to be pressed into a softened region of said glass material to affect formation of said glass material into said glass tube;

a feed table operable to be self-propelled by a motor at a desired speed and having a chuck for grasping a piercing-terminating end side of said glass material; and

a controller operable to control flow rate of a gas which is introduced into said muffle tube through a mass

flow controller, on the basis of a current or a voltage of said motor.